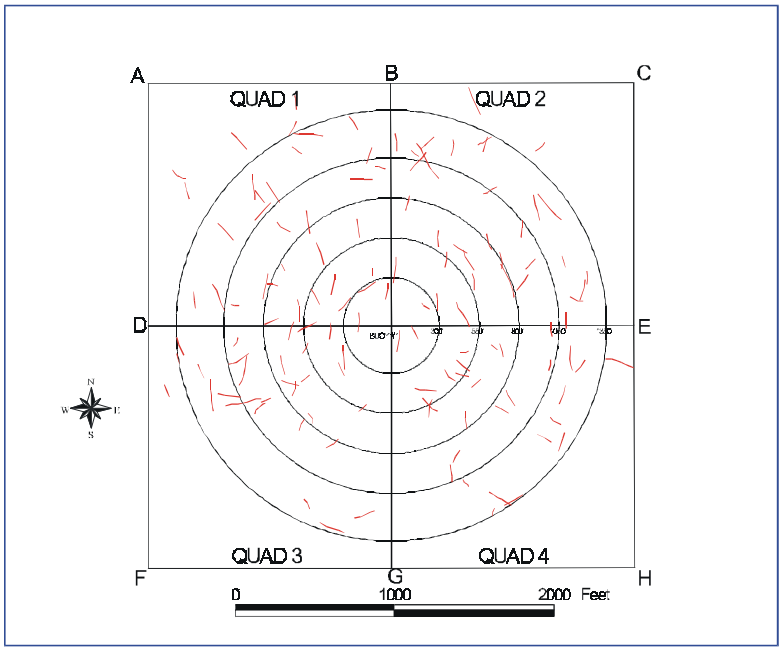
Automated Surveillance of Disposal Operations During the 1998 Passenger Ship Terminal Project at the Historic Area Remediation Site



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1.0 OBJECTIVES

The objectives of the Passenger Ship Terminal monitoring project were to: 1) acquire highly accurate navigation data from the operation of dredged material disposal scows in the Historic Area Remediation Site (HARS), and 2) distribute the information in a timely manner to both Great Lakes Dredge and Dock, and the New York District of the U.S. Army Corps of Engineers.

SAIC accomplished the first objective with the installation and servicing of the Automated Disposal Surveillance System (ADISS) on three scows, *Great Lakes 31*, *Great Lakes 32* and *Great Lakes 401*. The distribution of the information was accomplished after the navigation data were processed and plotted, showing the location of each disposal event in daily faxes, and the track lines of each transit in weekly summary reports.

2.0 ADISS SYSTEM DESCRIPTION

The ADISS system was a refined version of the original prototype developed for the U.S. Army Corps of Engineers - New York District's (NYD) monitoring needs during the 1997 Capping Project at the former Mud Dump Site. A complete description of the earlier system, called the New York Disposal Surveillance System (NYDISS), is presented in a technical report describing the results of the monitoring project (SAIC, 1997).

The system used for the Passenger Ship Terminal monitoring project consisted of a GPS and a DGPS receiver, a 10-megabyte data logger, a pressure sensor, and an Argos satellite transmitter. The receivers determined the location of each scow with an accuracy of 2-5 meters, and the logger recorded the navigation and pressure data at 5-minute or 6-second intervals depending on the scow's location during transit. Draft measurements were acquired from the pressure sensor installed in the ram well of the scows: a sudden decrease in the draft signaled the disposal of the load. During the disposal event the Argos transmitter sent the position of the scow to a passing satellite. Once the data were downlinked, it was sent to SAIC through an automated e-mail distribution system, where it was processed and plotted for display.

The two means of acquiring data worked in concert to monitor the activities of disposal operations at the HARS for both the managing agency and the dredging contractor. The Argos telemetry of disposal positions occurred in near real-time (overnight), while the internal storage of the track line data was accessed during service visits (once per week). If a short dump was shown by the Argos messages, then an unscheduled visit to the scow was made to download the recorded information. The stored track line data, once processed and plotted, provided the verification needed to confirm the Argos information. The entire process from disposal to confirmation required three to four days depending on travel from the SAIC Newport office and communications with NYD personnel.

3.0 ADISS INSTALLATION AND SERVICE

Three ADISS units were installed on split-hull scows *GL 31*, *GL 32* and *GL 401* at the Great Lakes Staten Island dock facility on March 23, 1998. Each installation consisted of mounting the ADISS unit on the outside of the doghouse, erecting the GPS, DGPS and Argos antennas on the roof, and placing the pressure sensor in a stilling well attached to the ladder in the ram well.

Once installed, the system was tested for proper signal reception and normal logic function, which were determined from the readout of a palmtop computer. Logic function was also demonstrated by the proper illumination sequence of indicator lights within ADISS. The red light flashed if the circuitry to the receiver antennas was corrupt. The yellow light signified activation of the GPS receiver, while the green light showed the pressure sensor was activated. If both the green and yellow flashed simultaneously, the scow would be filled and waiting for transit to the HARS. A solitary green light meant the scow was empty. The lights were also monitored by scow men during disposal operations.

Proper logic sequence depended on establishing the best pressure sensor thresholds for "full" and "empty" draft levels. Thresholds for the Passenger Ship Terminal project established during the ADISS installation at the Staten Island yard were based on previous experience at the Confined Disposal Facility (CDF) pit, where dense clay material was loaded into the scows, producing draft measurements as deep as 20-22 feet.

Routine service trips were made to the ADISS units on the Monday of each week to download the recorded data and check the units for malfunctioning equipment and proper battery voltage. Batteries with low voltages were replaced with recharged cells.

Dredging and disposal operations began on March 24 at the Passenger Ship Terminal, and ended 22 days later on April 14, 1998. During the initial loading, transit and disposal cycles, it was apparent that the fill thresholds set at the yard were not reached, and that no data were recorded during the first cycles of transit and disposal operations. "Full" draft conditions at the Passenger Ship Terminal were observed at 14-15 feet instead of the expected 20-22 feet. Once the adjustments were made for the lighter density material dredged, all ADISS units functioned properly during the remaining cycles of operation with one exception.

One unscheduled service trip was required during the second week of operation, when a short dump was indicated by the Argos-transmitted data, and an alert scow man reported the improper sequence of indicator lights on the ADISS unit. The problem was related to the threshold for the "empty" draft condition of the scow. Set for the minimum after the initial cycles, the threshold was reached during the return transit from the HARS, and triggered the Argos transmitter to send an erroneous short dump position. The solution was to adjust the position of the pressure sensor in the ramwell, so that the "empty" condition would be detected during disposal and not inadvertently during transit. The true disposal position and the complete trackline were recorded internally within the ADISS memory.

4.0 DATA PROCESSING AND ANALYSIS

All navigation and draft data were processed and analyzed at the SAIC Newport facility with software developed for the purposes of error checking, parsing, displaying and archiving the information from both the Argos-transmitted data and the ADISS internally stored information. Processing routines were written in Visual Basic, and plotting routines were created in ArcView as previously described (SAIC, 1997).

Data products of Argos-transmitted information consisted of plotting the disposal events at the HARS Cell #1. Each disposal location was annotated with the scow identity, trip number, date and time of event (Figure 1). Each event consisted of a pair of positions indicating the beginning and end of each disposal. The lines connecting the pairs of points indicated the area of the seafloor covered by the deposition of dredged material. Because of the scale of the figure, some pairs appear as a single point.

Data products of ADISS-stored information showed the track line of transit south from the Veranzano Bridge to the HARS (Figure 2), the track line through Cell #1 of HARS (Figure 3), and the track line and disposal position within the quadrants of Cell #1 (Figure 4). A record of the draft measurements taken during the transit, and showing the disposal points was also provided for each trip (Figure 5). In Figure 2, the track line plotted from the bridge to the HARS area was dotted, because the recording interval was set at 5 minutes; the solid track line within the HARS illustrated the 6-second recording interval.

Data products from the Argos-transmitted disposal positions and from the ADISS trackline records, were sent to Mr. Richard Murphy at Great Lakes and Mr. Brian May at NYD. The Argos data products were faxed daily, five days a week, while the ADISS data products were produced weekly and sent via over-night commercial carrier on Tuesdays.

4.1 Data Acquisition Results

Over the 22 day period of operations, 134 disposal trips were made to the HARS. Of the total, 129 trips or 96% were successfully recorded by the ADISS units. Five of the trips were not recorded due to the initial draft threshold settings, and no data were lost after the problem was corrected.

A comparison of target areas assigned for each quadrant (Table 1) with the locations of the disposal events recorded by ADISS showed 26% success. Scow positions in Figure 6 were placed according to the recorded ADISS information, and compared with trip numbers assigned to regions within each quadrant by the New York District. Disposal accuracy depended on the skill of the helmsman and the Disposal Inspector to position the scow and estimate its position. Estimates of position depended on accurately recording the position of the tug with DGPS, and determining the layback and relative orientation of the scow: all were potential sources of error for locating and positioning the scow over an assigned target area. Similar results were demonstrated during the 1997 Capping Project, where only 33% of the assigned targets cells were hit (SAIC, 1997).

A consistent offset was evident between the disposal positions acquired by ADISS and those calculated from the logs of the Disposal Inspector aboard the tug *William L. Colnon*. When paired with the disposal positions recorded by ADISS, the estimated positions of the scows were generally 1,000 feet to the Northeast regardless of scow (Figures 7 and 8). The offset was due to a problem with tug navigation since different ADISS units all showed the same results. Sixteen of the calculated disposals fell outside the bounds of HARS Cell #1. All estimated scow positions were calculated from the data recorded on the Inspector's log, including the tug's heading and position, distance to the bit, layback and orientation of the scow.

No consistent offset was evident between the disposal positions acquired by ADISS and those calculated from the logs of the Disposal Inspector aboard the tug *Sisters* (Figures 9 and 10). Twenty six of the logged positions were recorded within 250 feet of the ADISS recorded positions, while nineteen were between 250 and 500 feet. The remaining fourteen disposal positions were located more than 500 feet from the ADISS positions. Since the vessel was not equipped with Differential correction for the GPS signal, the difference of the positions estimated within 250 feet was understandable. However, over half of the positions estimated from the *Sisters* were not explained by the lack of a Differential corrected GPS signal. Seven of the differences were greater than 1,000 feet.

Two short dump events were indicated by the Argos-transmitted information. The first (trip # 46) resulted from the draft threshold issue discussed earlier, and was not validated by the ADISS track line information (Figure 11). The second short dump indication occurred during trip # 56 in the buffer area north of Cell # 4, which was validated by the track line data stored in the ADISS unit (Figure 12). When compared to the position recorded by the Disposal Inspector onboard the tug, the distance between the two positions was greater than two miles. It was clear from the track line plot that the reported position for the disposal event given by the Inspector was a blunder. We suspect the disposal was made adjacent to the 'NY' buoy located near the center of the Mud Dump Site.

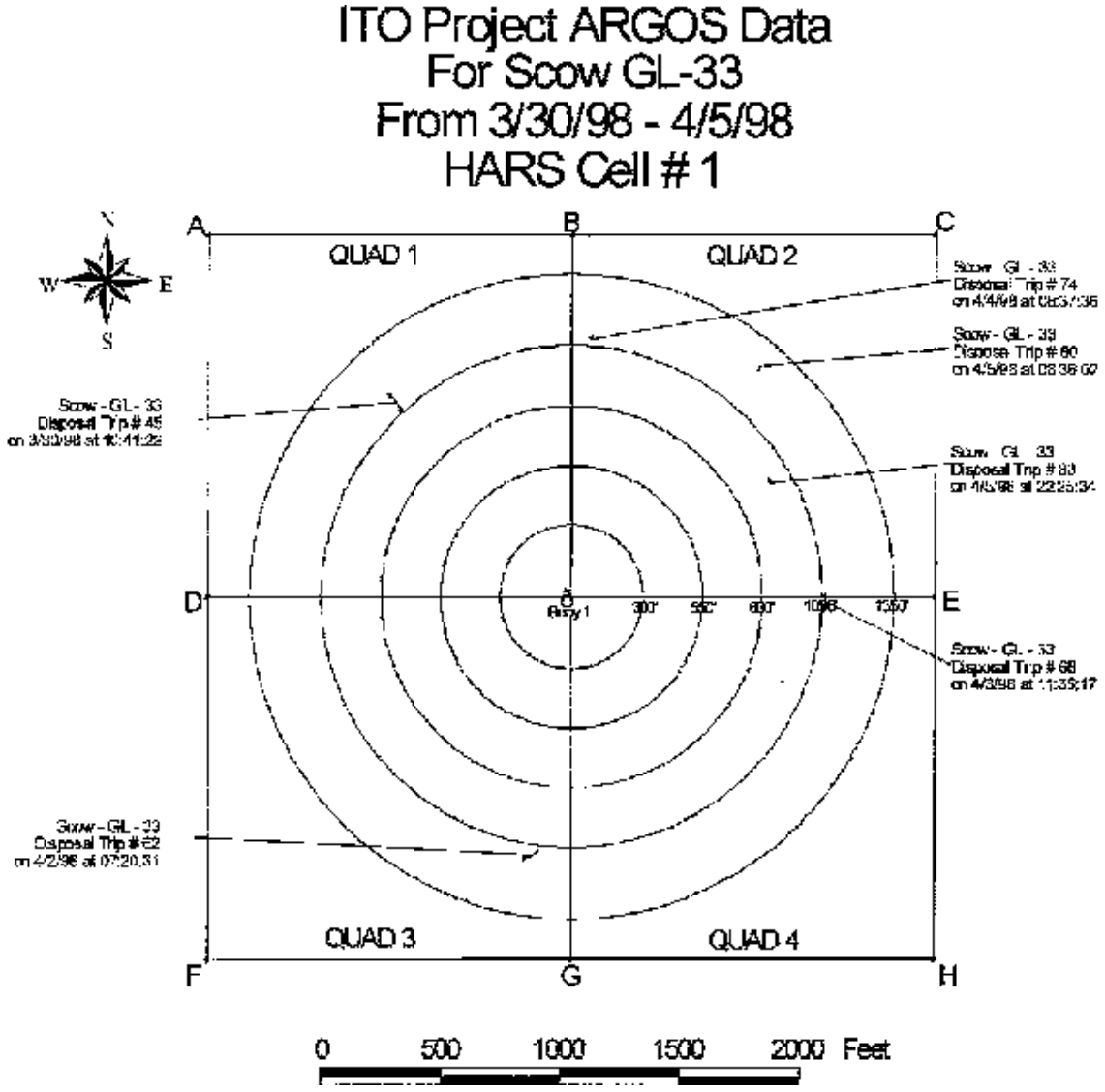

Figure 1. Example of ARGOS disposal locations.

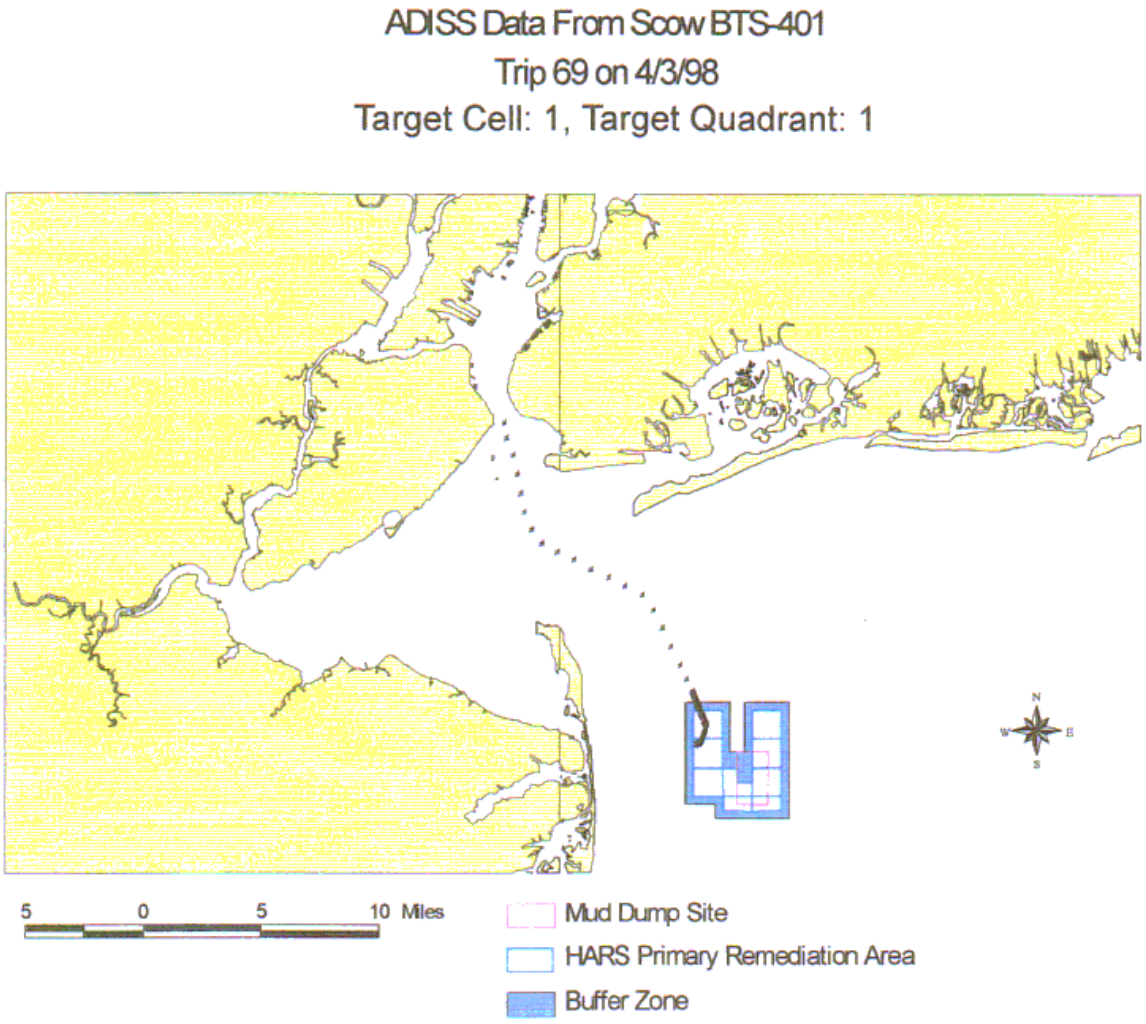

Figure 2. Example of ADISS data acquired during the transit to HARS.

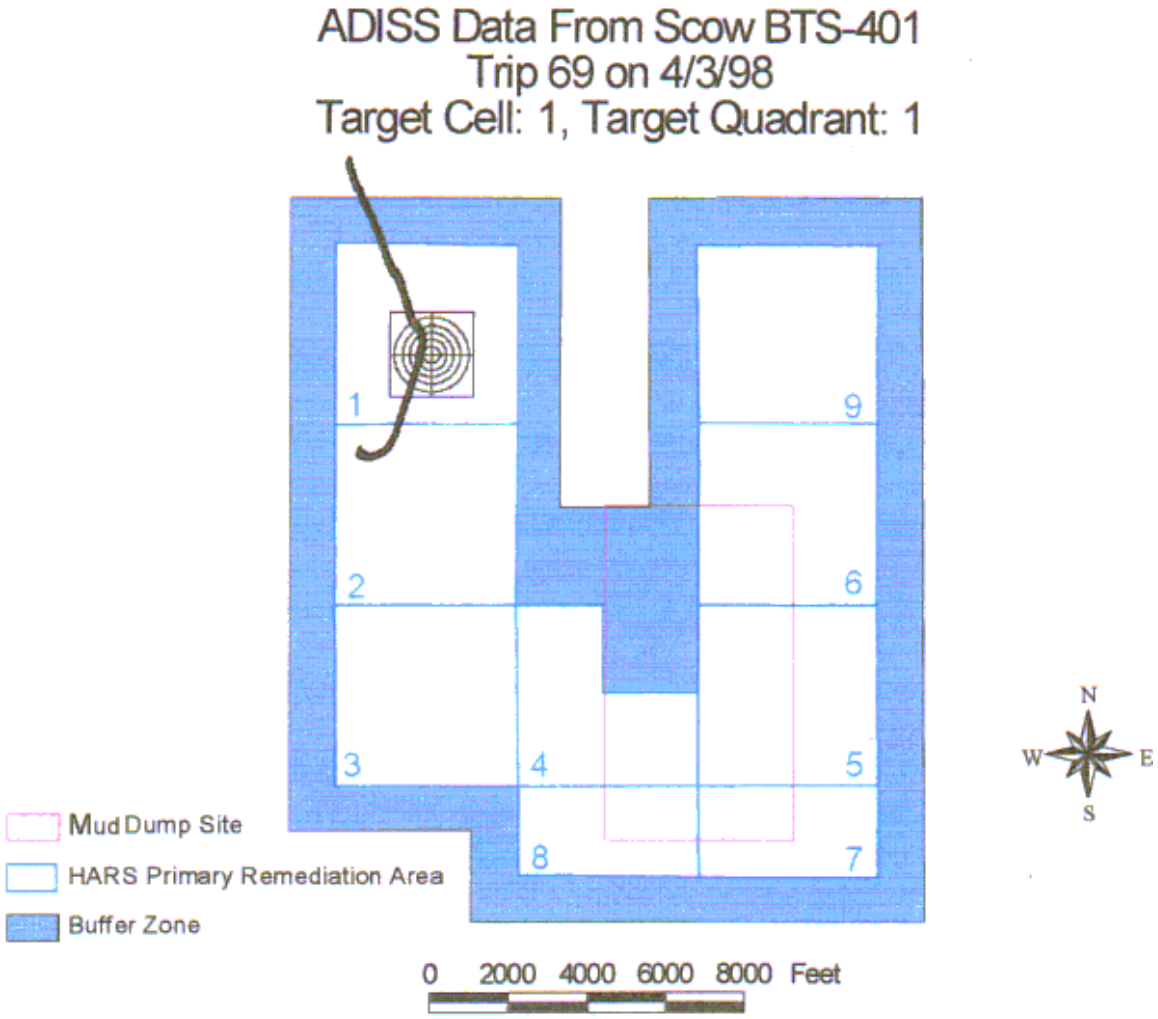

Figure 3. Example of ADISS data acquired while within the HARS.

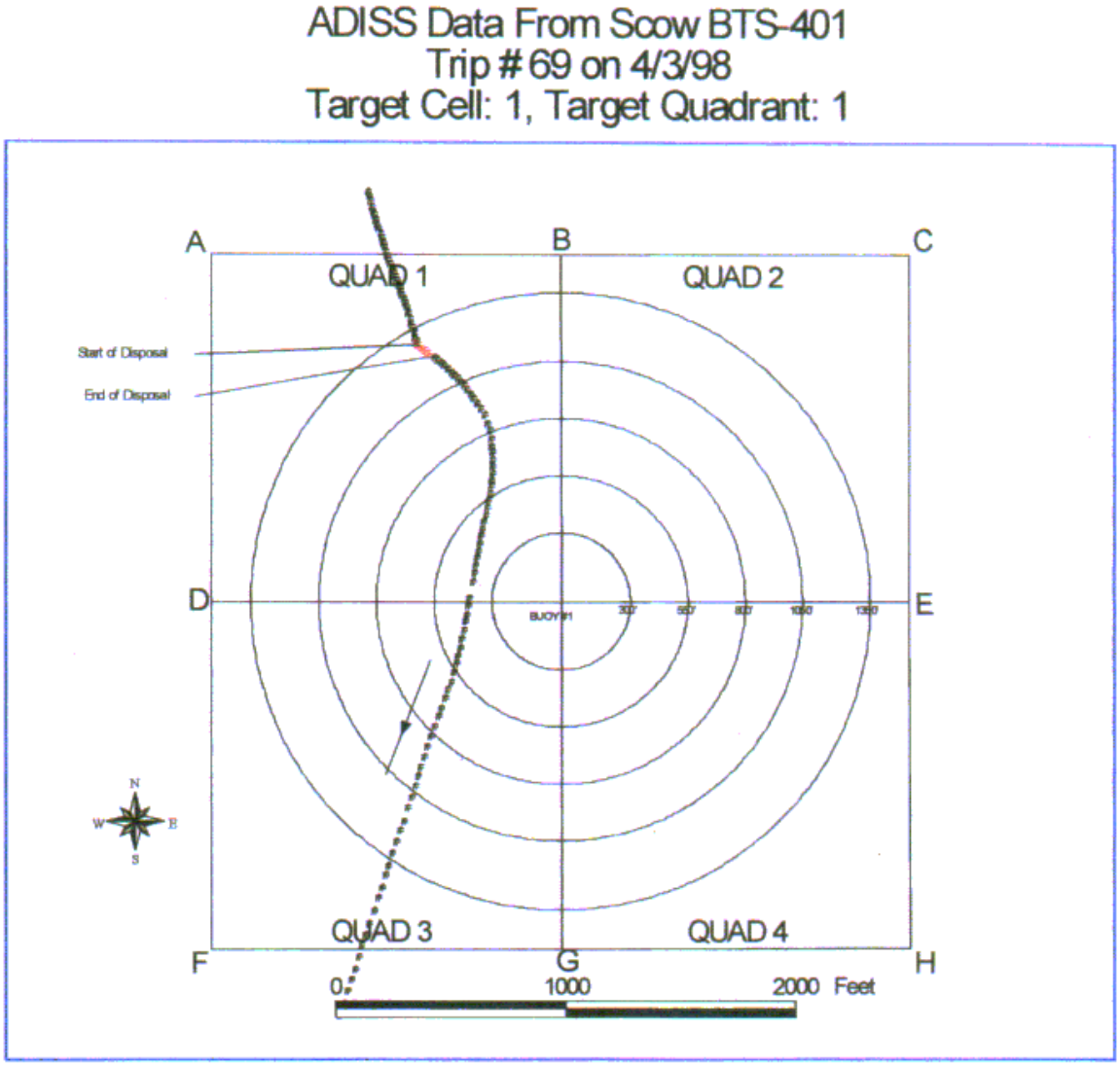

Figure 4. Example of ADISS data acquired within the disposal location of the HARS Cell 1.

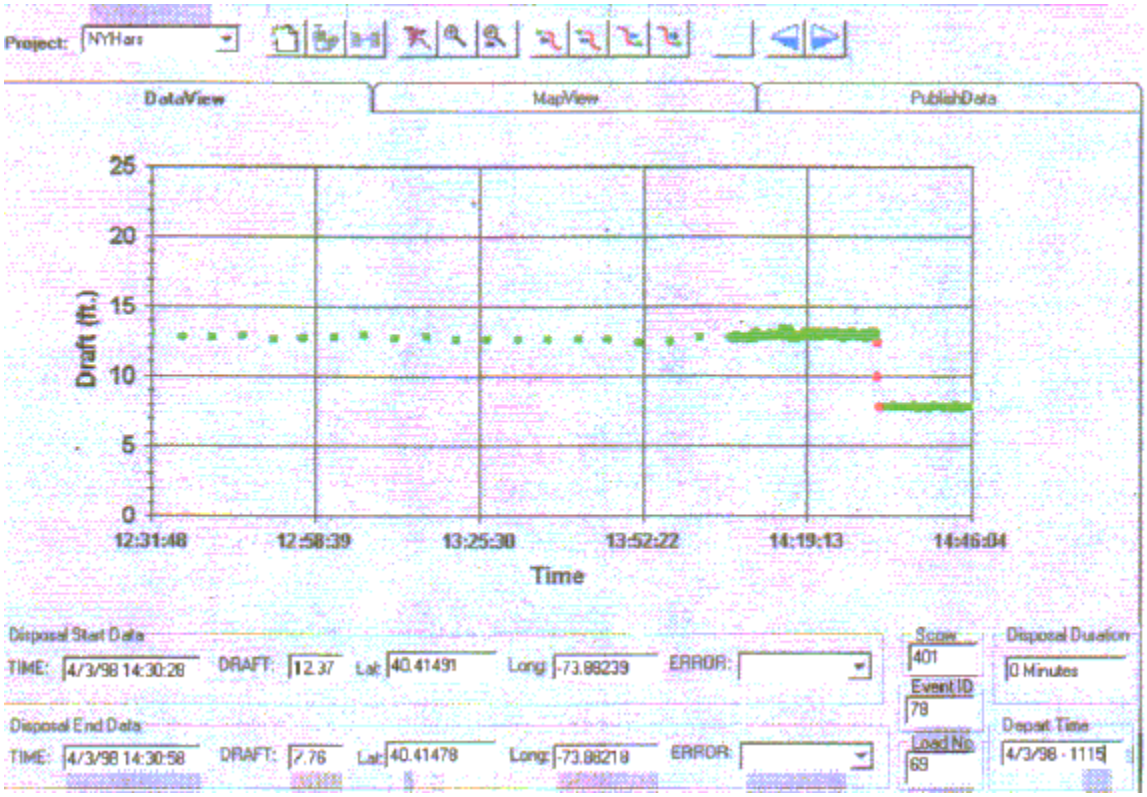

Figure 5. Example of ADISS data representing the time series of scow draft before and after disposal (green) and during disposal (red).

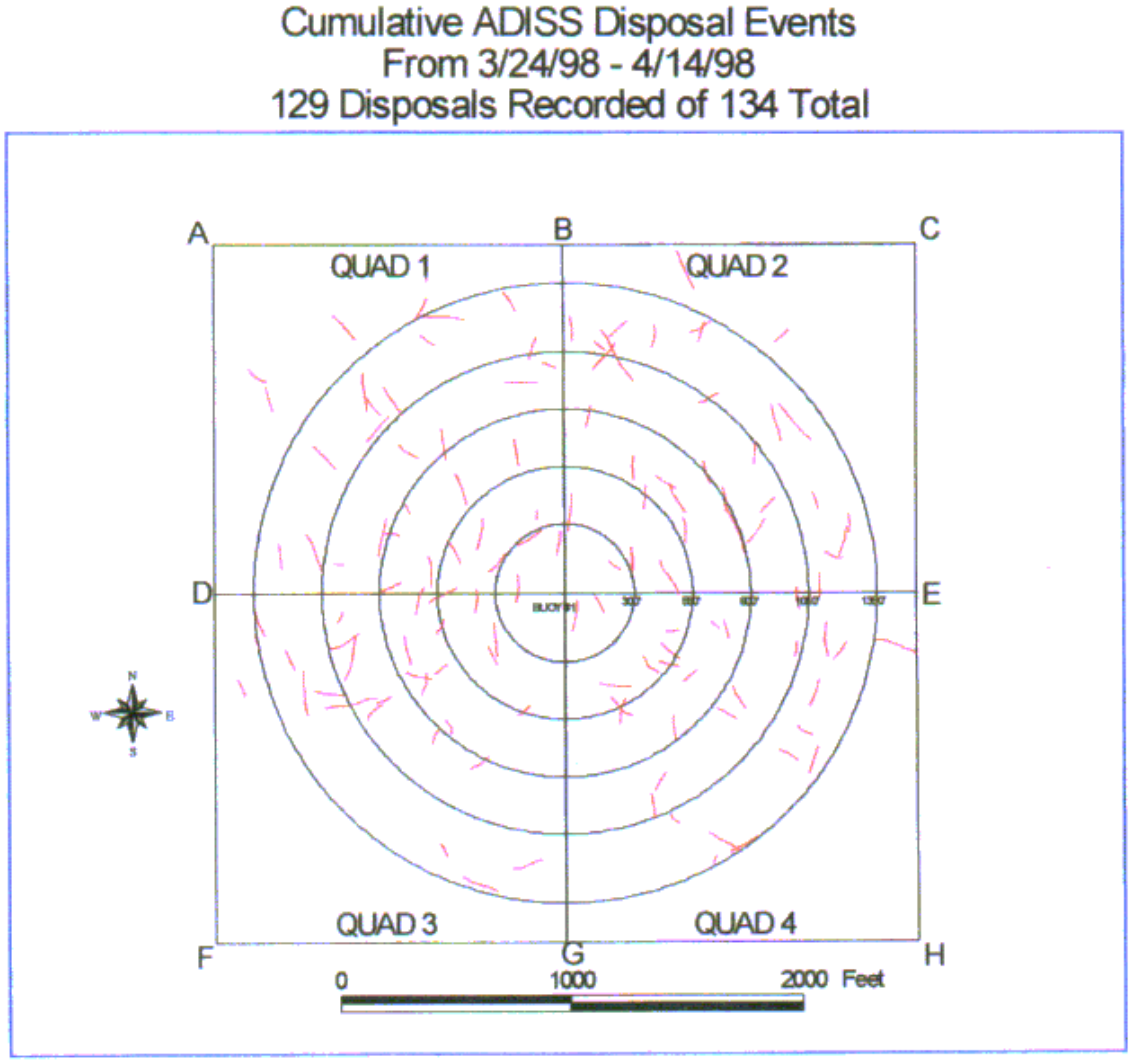

Figure 6. Composite of 128 disposal events recorded within the HARS Cell 1. (Load 56 was disposed outside of this location and therefore not included.)

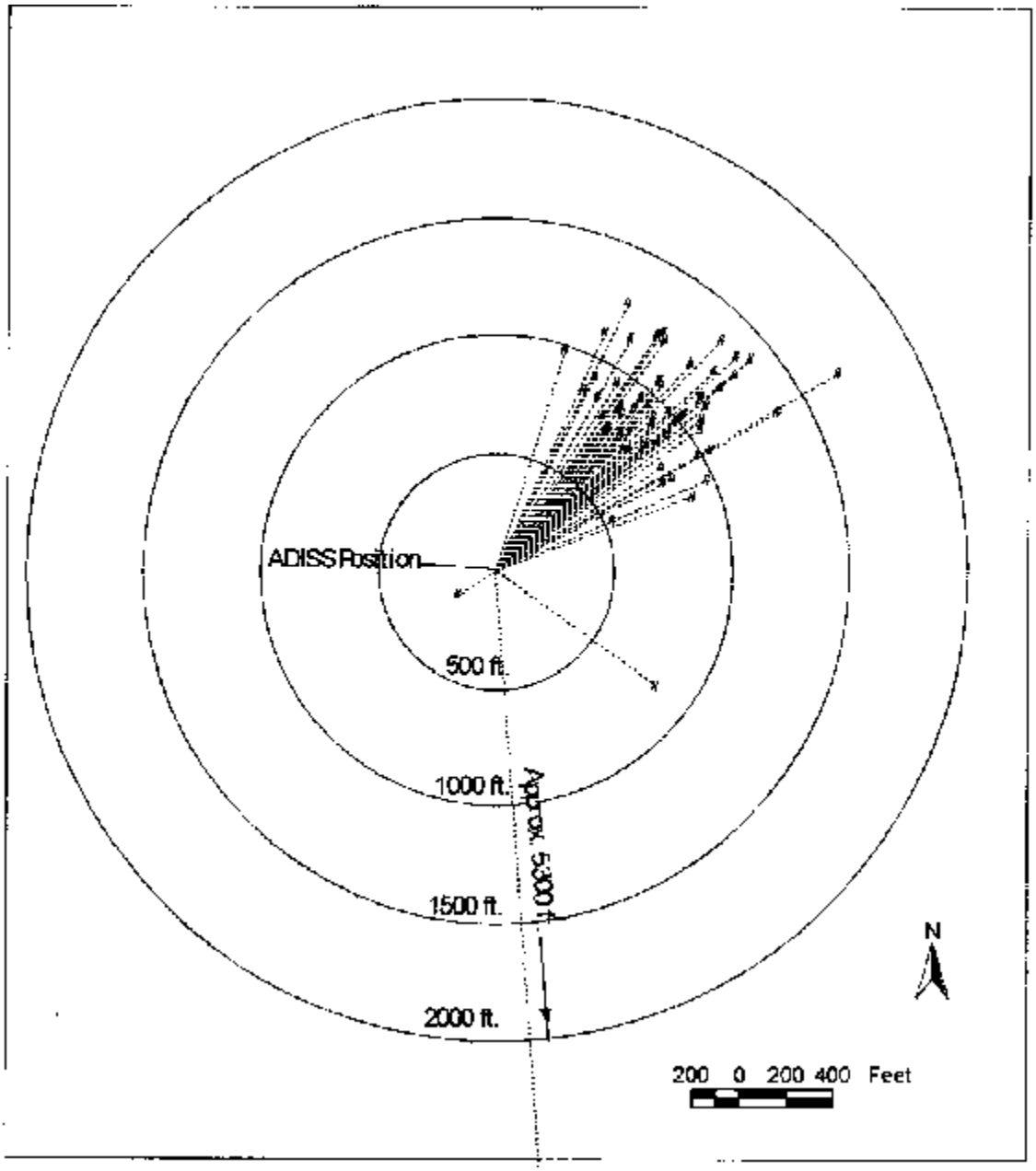

Figure 7. Comparison between ADISS scow position and position calculated from inspector logs for the tug *William L. Colnon*. The ADISS position for each disposal has been placed at the center of the figure.

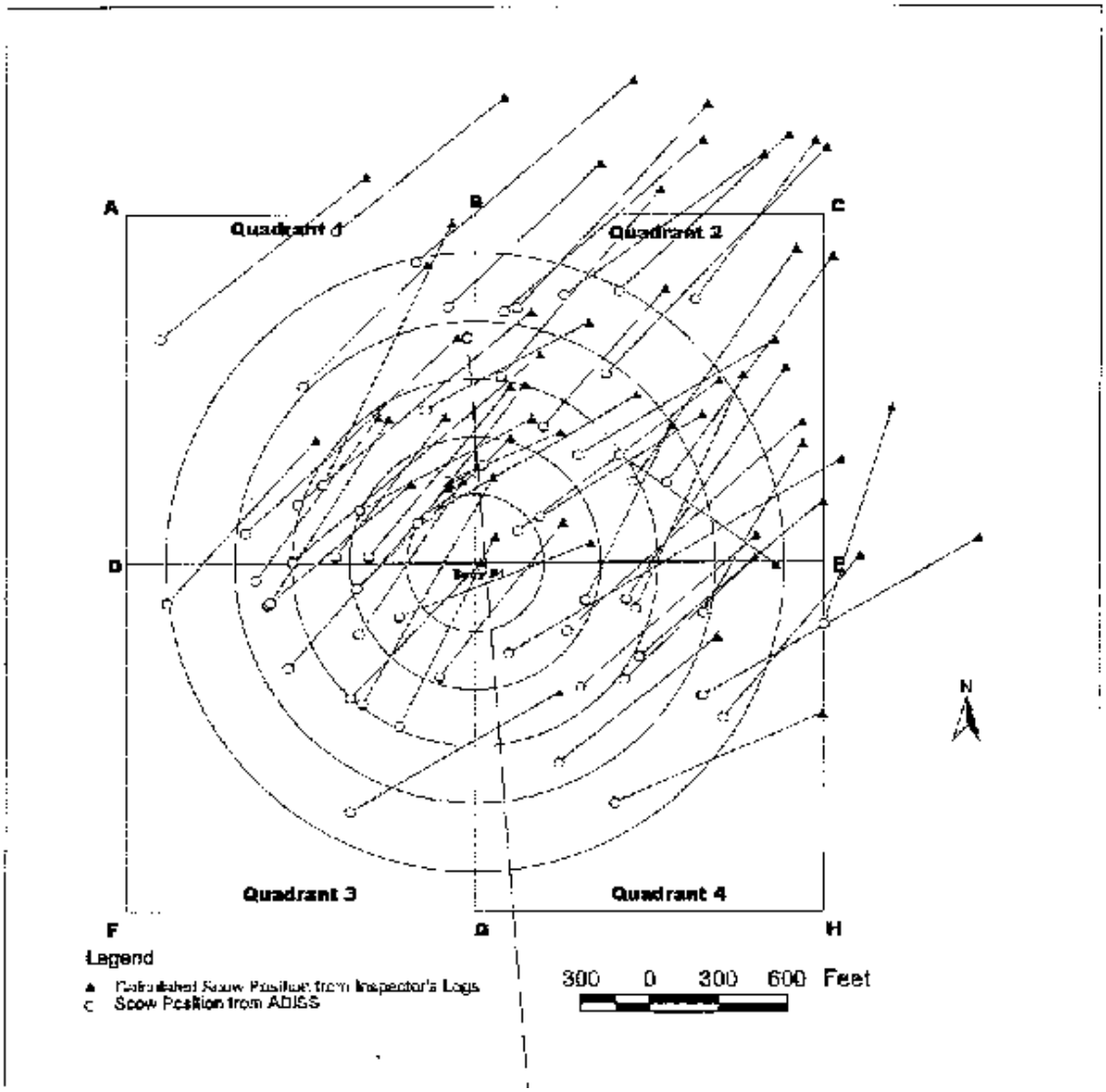

Figure 8. Calculated positions from ADISS unit versus calculated position from inspector logs for the tug *William L. Colnon.*

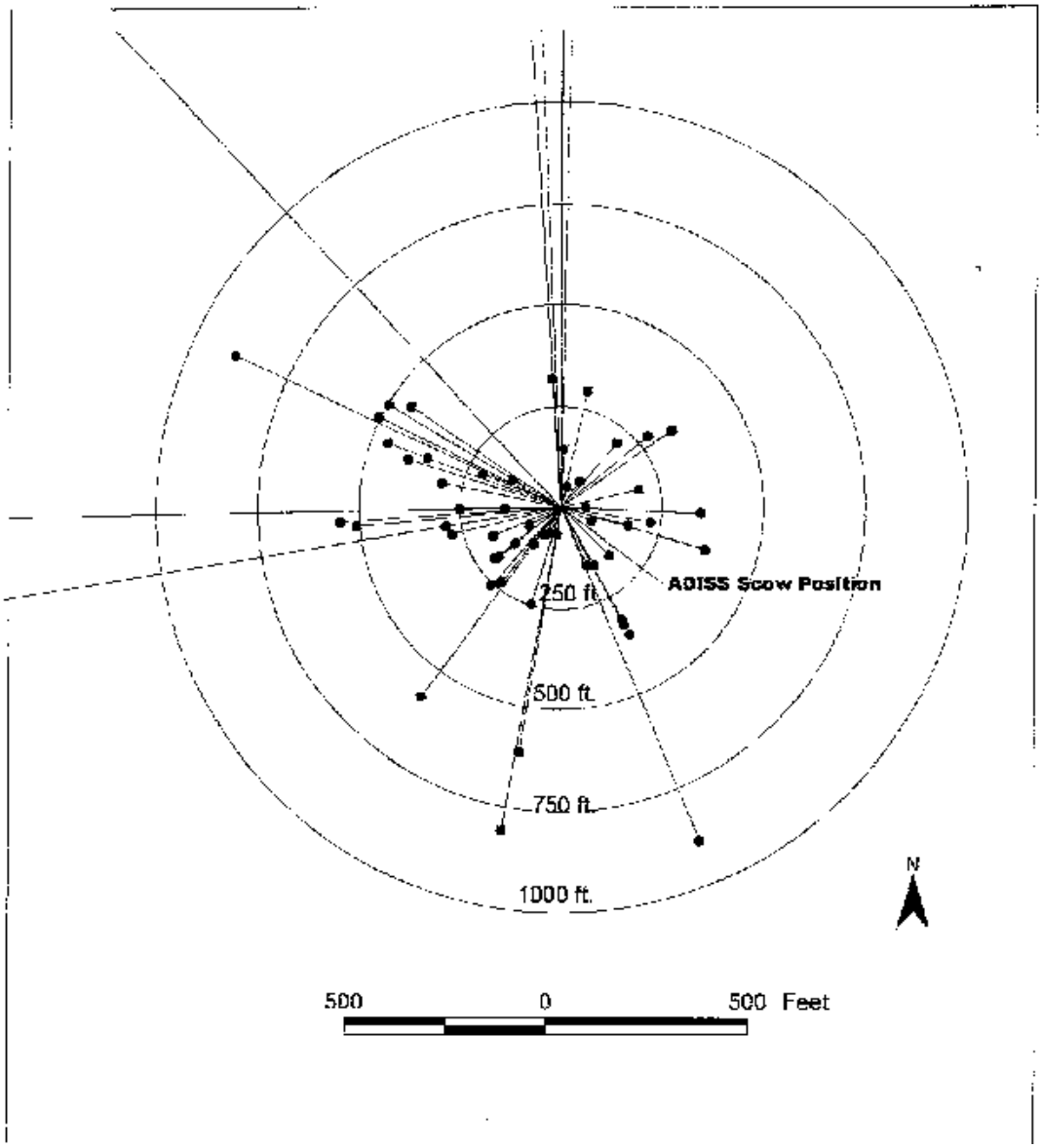

Figure 9. Comparison between ADISS scow position and position calculated from inspector logs for the tug *Sisters*. The ADISS position for each disposal has been placed at the center of the figure.

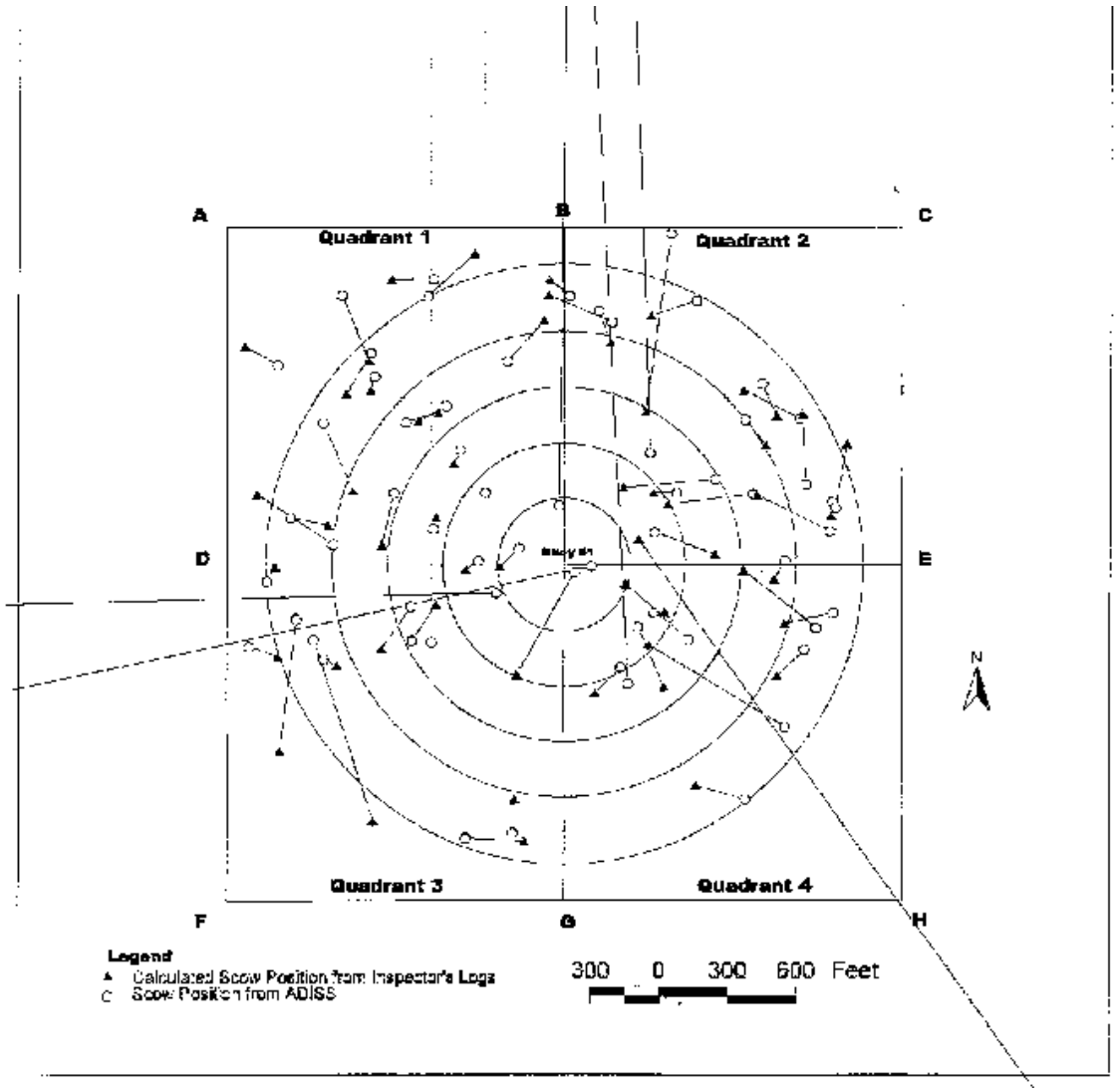

Figure 10. Calculated positions from ADISS unit vs. calculated position from inspector logs for the tug *Sisters*.

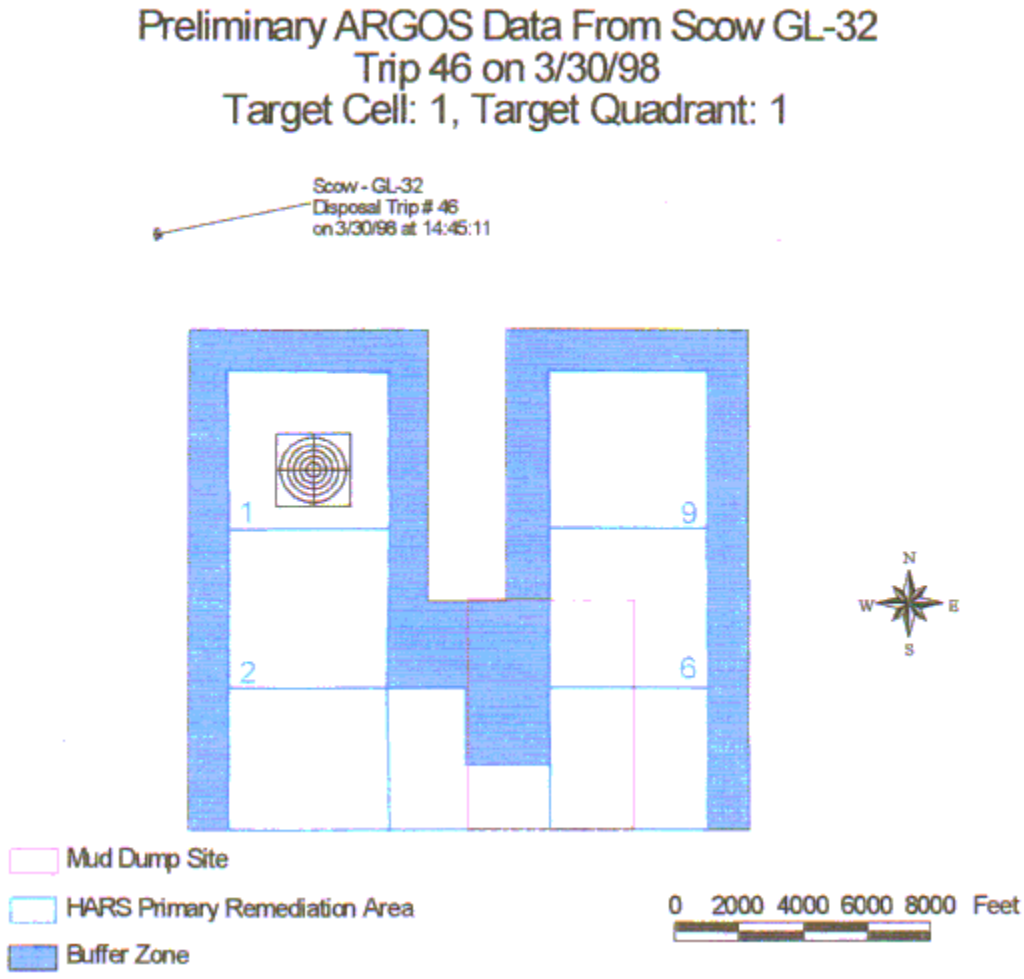

Figure 11. ARGOS transmitted short dump event for load 46 but not substantiated by ADISS recorded data.

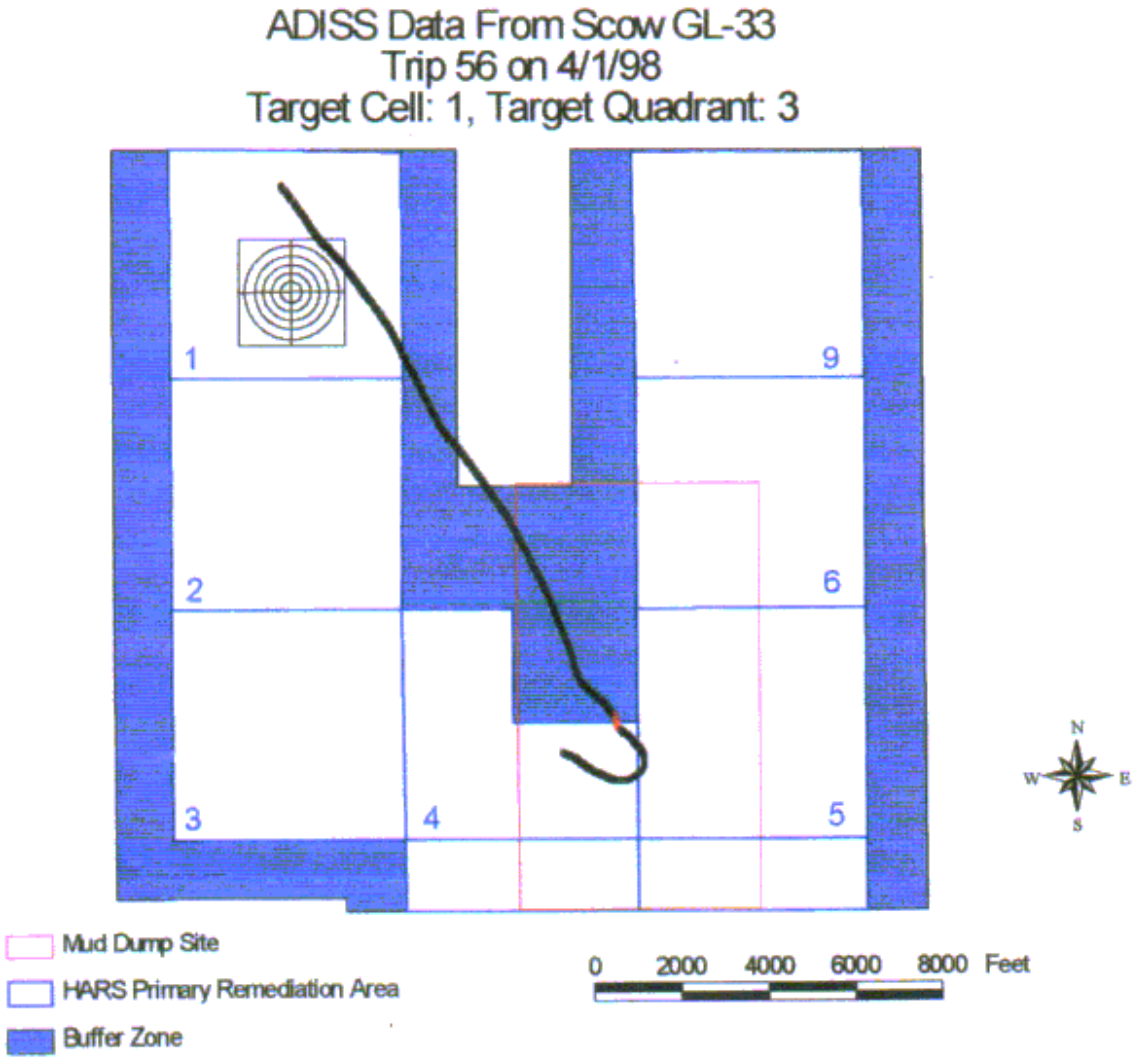

Figure 12. Transit data illustrating the short dump event for load 56.

5.0 SUMMARY AND RECOMMENDATIONS

The following summarizes the results of monitoring the disposal operations at the HARS during the Passenger Ship Terminal Project:

- ADISS units onboard three scows successfully recorded 96% of all disposal events. Five trips were not recorded, because of the initial problem with draft level threshold.

- The Argos data gave warning of two possible short dumps. One was disavowed, and the other was validated by the track line information recorded by ADISS.

- Disposal Inspector position data were often in error when compared to ADISS data.

The following are recommended to improve the management operations at the HARS:

- All tugs must have DGPS navigation system, which are calibrated prior to each project.

- Better knowledge of dredged material density and/or water content must be obtained to establish better draft thresholds.

- The addition of a page on the existing WWWeb Site (http://www.adissdata.com) to automatically process and display the Argos-telemetered data would reduce the reliance on manual processing, improve the response time for validation, and make the information readily available to NYD personnel for monitoring.

- Developing a link from the scow's ADISS output to the tug's helmsman display would provide improved navigation guidance. The display should include a background grid of target areas, and store the disposal position information automatically to validate the actions of the helmsman.

6.0 REFERENCES

SAIC. (1997). Automated Surveillance of Disposal Operations during the 1997 Category II Project at the New York Mud Dump Site. Report #63 of the New York Mud Dump Site Studies. USACE-CENAN, Contract No. DACW51-95-D-0027. SAIC Report No. 409.

APPENDIX A

Table 1

HARS Placement Guidelines and Results for Passenger Ship Terminal Project

QUADRANT	TRIP NO.	RADIAL DISTANCE FROM BUOY 1	Successful Placements	Unsuccessful Placements
Quadrant 1:				
	1-2	50-300ft		
	9-11	325-550ft		9,10,11
	21-25	575-800ft	21,23	22,25
	41-47	825-1050ft	43,44	41,42,45,46,47
	69-79	1075-1350ft	69,73,76	70,71,72,74,75,77,78,79
	113	50-300ft		113
	117-118	325-550ft		117,118
	125-126	575-800ft	126	125
	133-135	825-1050ft		133,134
Quadrant 2:				
	3-4	50-300ft	3	4
	12-14	325-550ft		12,13,14
	26-30	575-800ft	26,30	27,28,29
	48-54	825-1050ft	51,54	48,49,50,52,53,
	80-90	1075-1350ft	80,81,84,87,88,89,90	82,83,85,86
	114	50-300ft		114
	119-120	325-550ft	119	120
	127-128	575-800ft		127,128
	136-138	825-1050ft		
Quadrant 3:				
	5-6	50-300ft		5,6
	15-17	325-550ft	15,16	17
	31-35	575-800ft	32,35	31,33,34
	55-61	825-1050ft	57	55,56,58,59,60,61
	91-101	1075-1350ft	96,100	91,92,93,94,95,97,98,99,101
	115	50-300ft		115
	121-122	325-550ft		121,122
	129-130	575-800ft	130	129
	139-141	825-1050ft		
Quadrant 4:				
	7-8	50-300ft		7,8
	18-20	325-550ft		19,20
	36-40	575-800ft		37,38,39,40
	62-68	825-1050ft		
	102-112	1075-1350ft	105,107,110,111	
	116	50-300ft		
	123-124	325-550ft		
	131-132	575-800ft	132	
	142-144	825-1050ft		
Number of disposals that missed target =				95 (73.6%)
Number of disposals that hit target =			34 (26.4%)	
Total number of disposals recorded =			129	
Buoy 1 Location:		40°24.71N, 73°52.81W		